



Department of Public Works and Highways Flood Control Management Cluster

GEO GROUP ON
EARTH OBSERVATIONS

Global Centre of Excellence for
Water Hazard and Risk Management

ICHARM

International Centre for Water Hazard and Risk
Management under the auspices of UNESCO

Flood Mitigation in Philippines



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Project Director

Outline of Presentation

1. Flooding Scenario in the Philippines

- ▶ Why is Metro Manila and Surrounding Areas Perennially Flooded?
- ▶ 2009 Typhoon Ondoy Metro Manila Flooding

2. Policy Direction / Framework

- ▶ World Bank Proposed Projects
- ▶ Mangahan Floodway
- ▶ Paranaque Spillway
- ▶ Laguna Lakeshore Ringdike Project
- ▶ Marikina Dam

3. Actions / Challenges to Mitigate Flooding

- ▶ Completed and On-going Initiatives

The Philippines

Water-Related Disaster Data

- 7, 107 islands
- Land Area : 298,170 km²
- Population : 105 Million
- Annual rainfall : 2,400 mm
- 92.5% of disasters caused by typhoons
- Ranked 1st in the world: vulnerability to typhoons
- Ranked 3rd in 2012 World Risk Index Report



the Philippines



ta in Key Cities
(-Year Average)



Flood Risk Index

Philippine Flood Risk Index Basic Concept

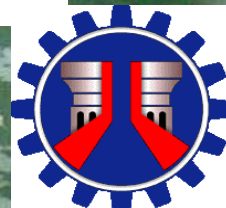
Philippine Flood Risk Index (PFRI_c)

$$PFRI_c = \frac{\text{Hazard} \times \text{Exposure} \times \text{Basic Vulnerability}}{\text{Capacity (Soft Countermeasures + Hard Countermeasures)}}$$

[Five (5) Sub-Indices]

1. Hazard Index (H)
2. Exposure Index (E)
3. Basic Vulnerability (V)
4. Capacity (Soft Countermeasures) (CS)
5. Capacity (Hard Countermeasures) (CH)

PHILIPPINES



River Basins in the Philippines

- **18 Major River Basins**
 - Catchment Area > 1,400 km²
- **421 Principal River Basins**
 - Catchment Area > 40 km²
 - With intense rainfall:
 - ✓ overflowing of waterways
 - ✓ inundation and deposition of sediment in flood plains
 - ✓ extensive flood damages often result.

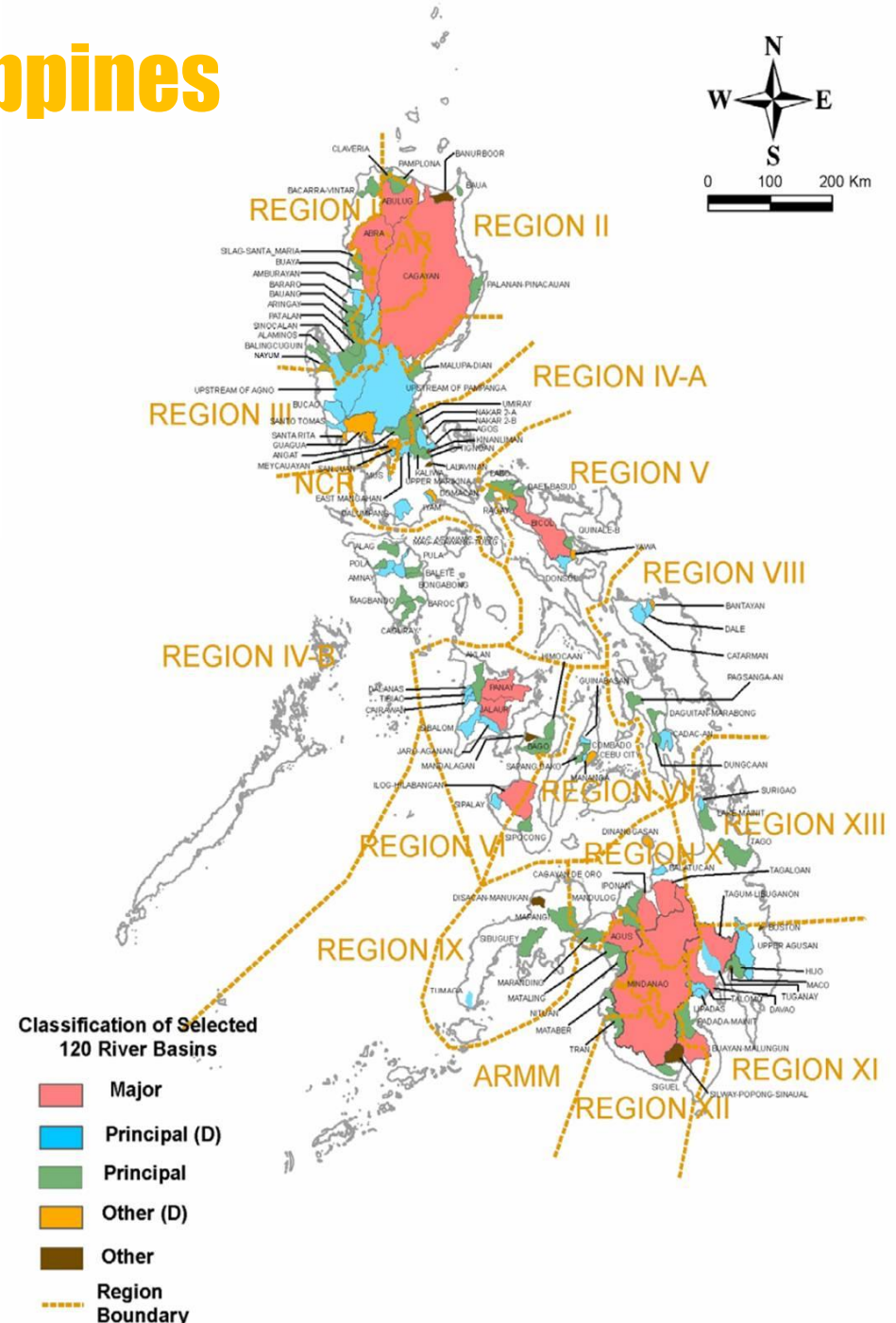


Table Recorded Annual Flood Damages in the Philippines

| Year | Population Affected | | Causalities | | | House Damaged | | Damage Value* (\$ million) |
|------|---------------------|-----------|-------------|---------|---------|---------------|-----------|-------------------------------|
| | Families | Persons | Dead | Missing | Injured | Totally | Partially | |
| | | | | | | | 1,101 | 30.66 |
| | | | | | | | 9,251 | 26.52 |
| 1982 | 266,476 | 1,569,017 | 337 | 223 | 347 | 84,027 | 97,485 | 36.54 |
| | | | 126 | 168 | 28 | 29,892 | 85,072 | 10.90 |
| | | | 1,979 | 4,426 | 732 | 310,646 | 313,391 | 8.67 |
| 1985 | 318,106 | 1,643,142 | 211 | 300 | 17 | 8,204 | 211,151 | 0.6 |
| | | | 171 | 43 | 155 | 3,162 | 14,595 | 38.29 |
| | | | 1,020 | 213 | 1,455 | 180,550 | 344,416 | 182.56 |
| 1988 | 1,173,994 | 6,081,572 | 429 | 195 | 468 | 134,344 | 585,732 | 180.73 |
| | | | 382 | 89 | 1,088 | 56,473 | 184,584 | 93.63 |
| | | | 676 | 262 | 1,392 | 223,535 | 636,742 | 244.02 |
| 1991 | 150,804 | 750,335 | 5,201 | 4,278 | 357 | 15,458 | 83,664 | 1.54 |

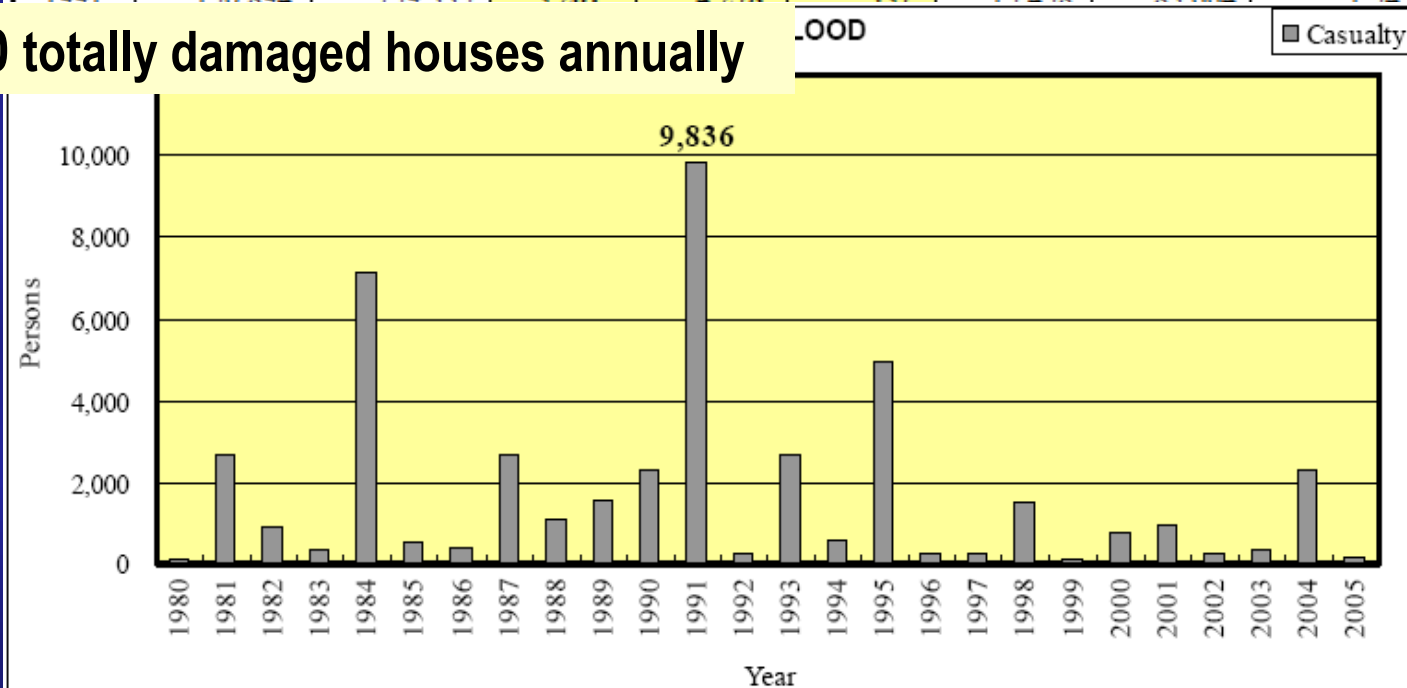
\$ 208 Million (CY 1970-2010 Damage to Economy Data)

\$ 168 Million lost annually

700 persons killed annually

2.8 M people affected annually

77,000 totally damaged houses annually



Recent Mega Flood Disasters

Philippine Destructive Typhoons in the last 10 years (2006-2016)

| RANK | NAME OF TYPHOON | DATE | DEATHS | COST IN DAMAGE (\$) |
|------|--------------------------|----------------------|--------|---------------------|
| 1 | Typhoon Haiyan | Nov. 6-8, 2013 | 7,041 | \$1.98B |
| 2 | Typhoon Pablo | Dec. 2-12, 2012 | 1,900 | \$930M |
| 3 | Typhoon Ketsana | Sept. 26-29, 2009 | 956 | \$430M |
| 4 | Typhoon Washi | Dec. 16-18, 2011 | 1,257 | \$35M |
| 5 | Typhoon Frank | June 18-22, 2008 | 557 | \$296M |
| 6 | Typhoon Milenyo | Sept. 25-26, 2006 | 213 | \$147M |
| 7 | Typhoon Reming | Nov. 30, 2006 | 1,479 | \$26.66M |
| 8 | Typhoon Violeta / Winnie | Nov. 22-Dec. 3, 2004 | 1,232 | \$178M |
| 9 | Typhoon Washi | Dec. 16-18, 2011 | 1,257 | \$35M |
| 10 | Typhoon Koppu | Oct. 19, 2015 | 12 | \$3.96M |



WHY IS THE FLOOD PROBLEM IN MANILA SO HUGE?



LOOK BACK ON FLOOD CAUSE

- Occurrence of extreme rainfall amount and intensity.

(According to PAGASA the 24-hr rainfall of 455mm recorded from 8am Saturday to 8am Sunday at the Science Garden in Quezon City is equivalent to a return period of more than 100 years.)

- Existing river channels do not have the capacity to contain extreme discharge

(Pasig River has a present flow capacity of 500m³/s, Marikina River with a 900m³/s, and in Cainta, Antipolo, Angono & Taytay with 22m³/s each)

- Existing Internal drainage systems in Metro Manila cannot contain the unusual runoff *(JICA Study on the Drainage Improvement in the Core Area of Metropolitan Manila, March 2005)*

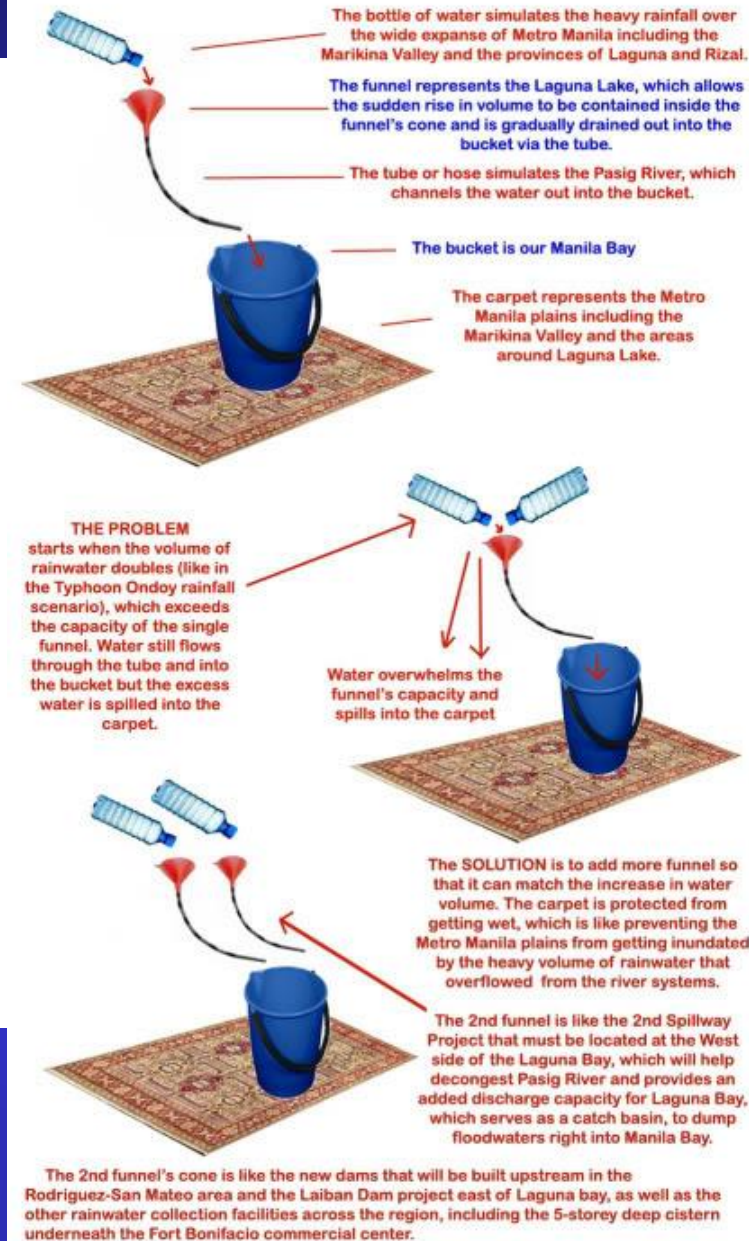
(Old drainage system constructed in 1975 already 70% silted; the runoff coefficient varies from 0.4-0.5. At present, due to rapid urbanization, the runoff coefficient was significantly increased.)

- Existing internal drainage systems are clogged up by 70% due to indiscriminate throwing of garbage.

Demonstration on Metro Manila Flooding Scenario

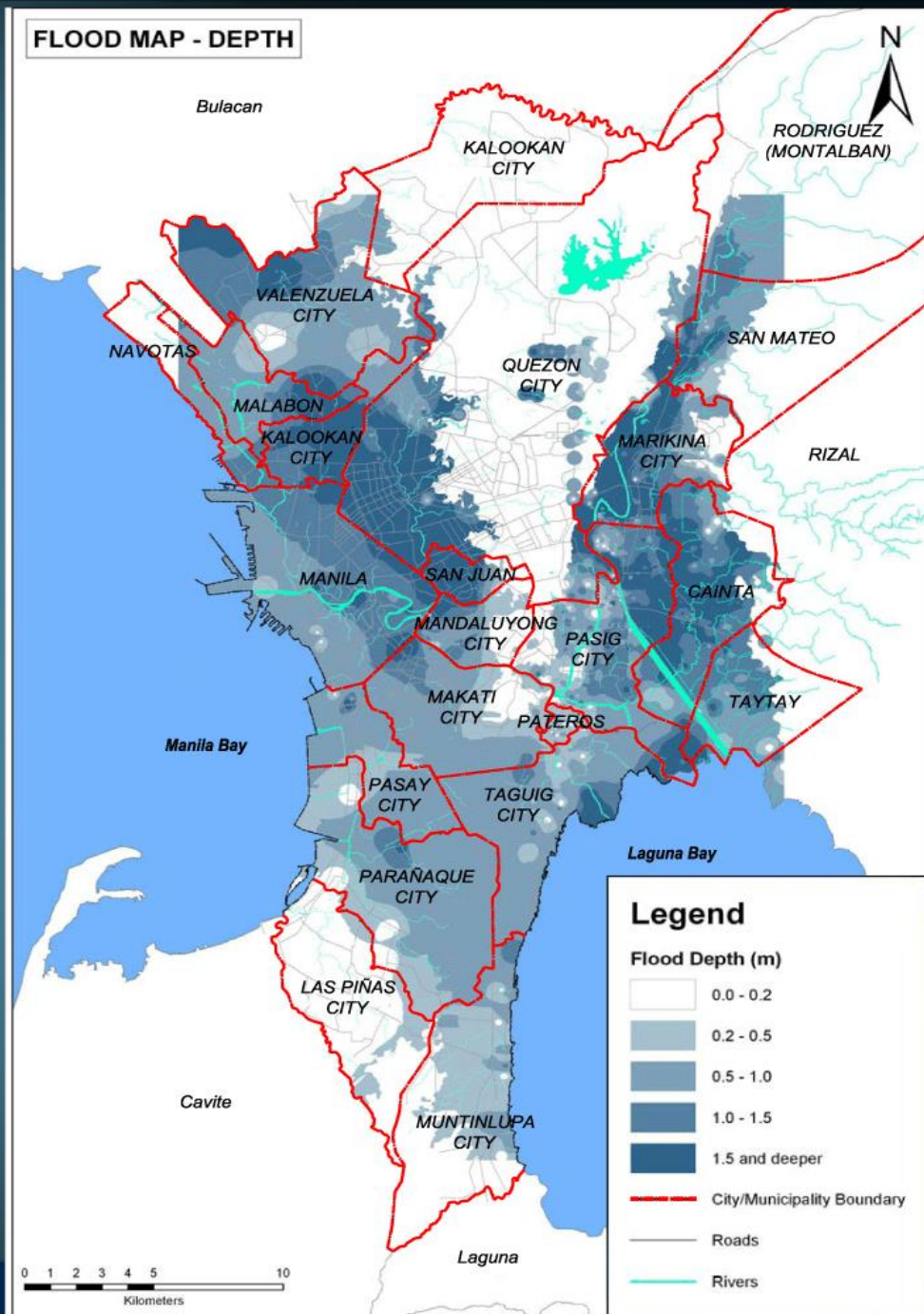
Simulation using a bucket, funnel, hose and a bottle of water

Flipzi's Cove <http://z6.invisionfree.com/flipzi>



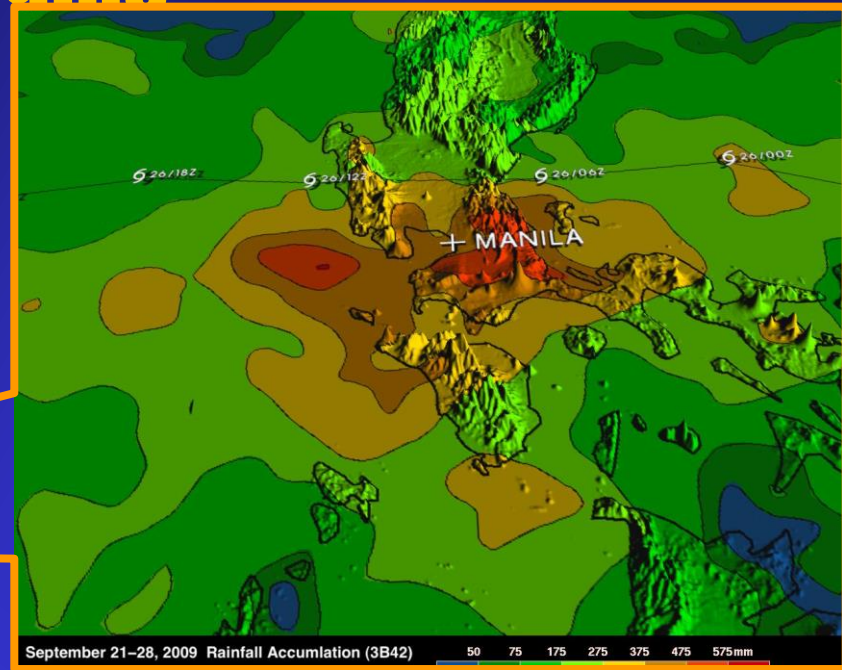
**FLOOD CONDITIONS IN METRO
MANILA DURING TYPHOON KETSANA
IN 2009**

Flood Condition by Ondoy in Pasig Marikina River Area

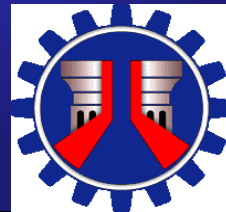


2009 Metro Manila Flooding

Typhoon Ketsana (26 Sept 2009)

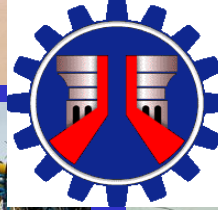


- Tropical Rainfall Measuring Mission (TRMM) / NASA – Multi Satellite Precipitation Analysis (MPA) showed Typhoon 'Ketsana' poured **575mm** of rainfall (**6hr Rainfall**)
- Monthly ave. (November) rainfall in manila was poured over in 1 day.



2009 Metro Manila Flooding

Typhoon Ketsana (26 Sept 2009)



- Affected
- Casualty
- Damage

9.3 million
1,000 people dead
2.7% of GDP

MASTER PLAN FOR FLOOD MANAGEMENT IN METRO MANILA AND SURROUNDING AREAS

Master Plan for Flood Management in Metro Manila and Surrounding Areas



Based on river basins:
Pasig-Marikina River
Basin and Laguna Lake
Basin.

Total area: 4,354 km²

Total Population: 17.1 M

**Boundary of
Study Area and
the River Basins**



Department of Public Works and Highways

UPMO-FLOOD CONTROL MANAGEMENT CLUSTER

ON-GOING FLOOD CONTROL PROJECTS IN METRO MANILA

VOM Flood Control Project

KAMANAVA Flood Control Project

Contract Package 10.1 - River Improvement Works along Upper Marikina River (Left Bank) Marikina Side

Contract Package 3 - River Improvement Works along Upper Marikina River (Upstream of Marikina Bridge)

Contract Package 7 - River Improvement Works along Upper Marikina River (Left Bank) Marikina Side

Contract Package 4 - River Improvement Works along Upper Marikina River, (Left Bank) Marikina Side

Contract Package 2 & 3 - River Improvement Works along Upper Marikina River (Upstream of Marikina Bridge)

Contract Package 1 & 2 - Pasig River Channel Improvement Project, Phase III, Pasig-Marikina River, NCR, JICA PH-P25

Metro Manila Flood Control Project-West of Mangahan Floodway



Components

- Lakeshore Dike: 10.8 km long including 1 bridge (150 m) from Lower Bicutan to Mangahan Floodway
- Bridge: 1 site (Napindan; 150 m)
- Parapet Wall: 5.16 km in total along Napindan River Banks
- Floodgates: 8 sites
- Pumping Stations: 4 sites (Total Capacity ; 36 m³/s)
- Regulation Ponds: 4 sites (at each pumping station)



Proposed Marikina Control Gate Structure



Pasig Marikina Channel Improvement Project

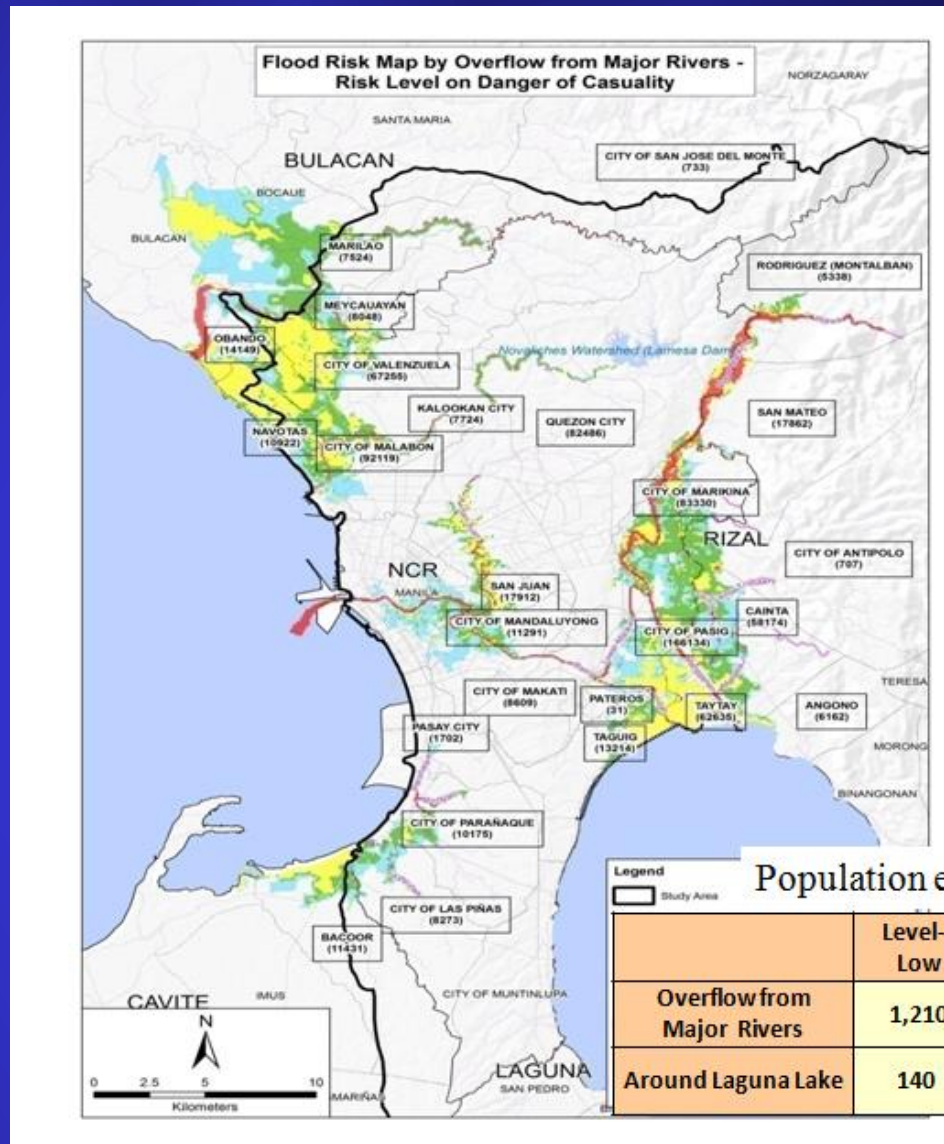


Policy Direction / Framework

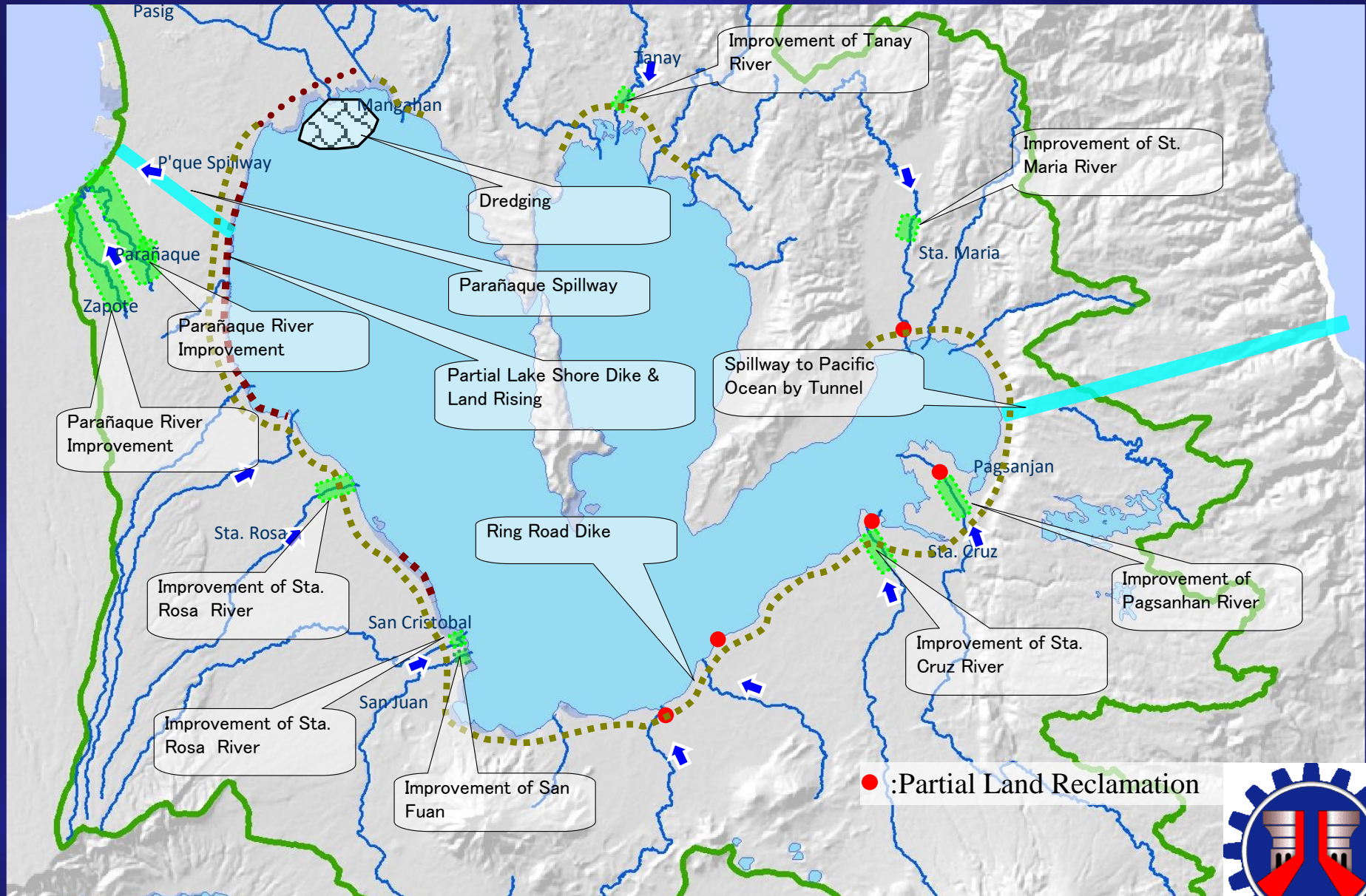
DPWH Efforts to Mitigate Flooding in Metro Manila

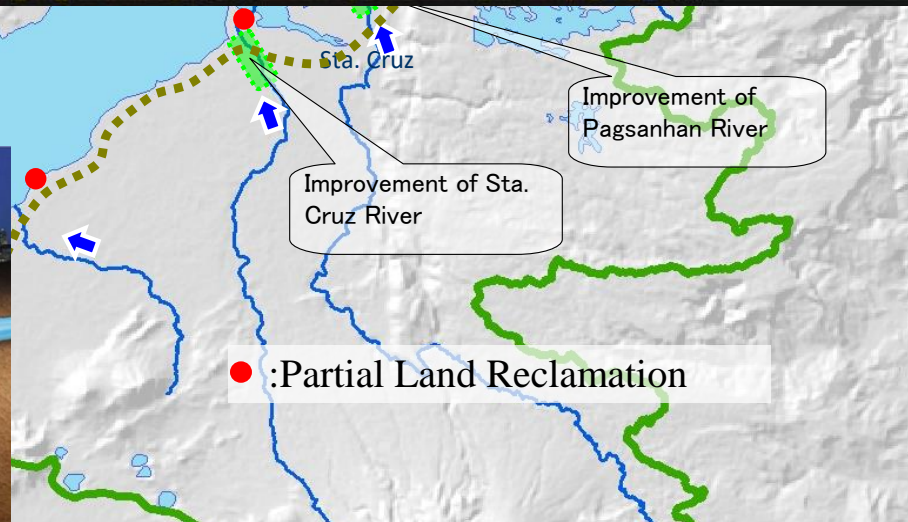
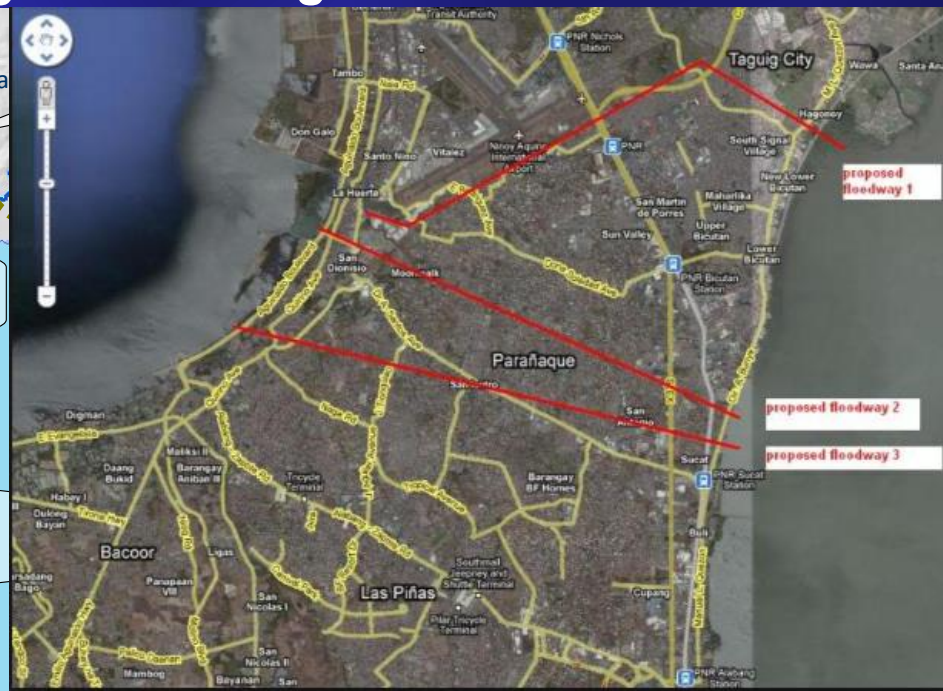
1. Flood Management Master Plan for Manila

- Prioritize the construction of flood structures in highly flood prone areas
- Bureau of Design Upgrades on Flood Control and Drainage Standards
 - a) Min. flood return periods of drainage pipes (15 yr flood); esteros/creeks (15 yr flood);
 - b) principal and major rivers (50 yr flood).



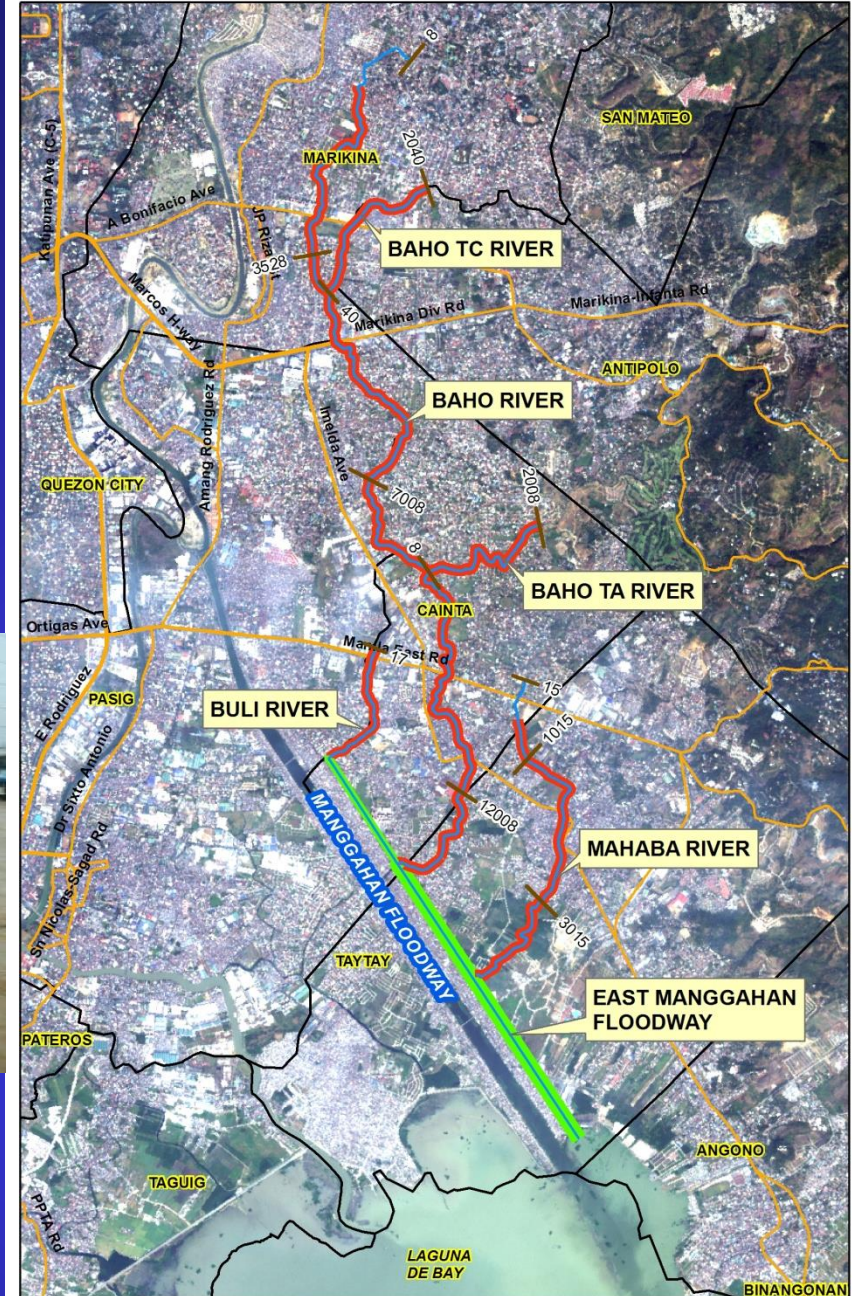
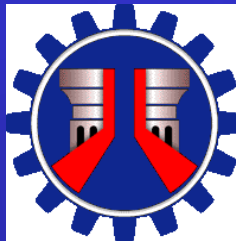
Laguna Lakeshore: Long Flood Control Projects





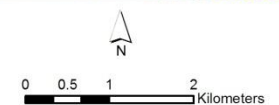
East Mangahan Floodway

Including Improvement of Inflow Rivers



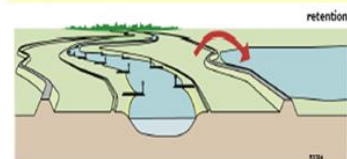
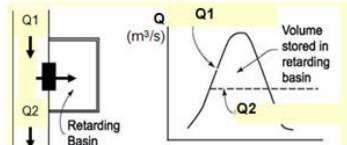
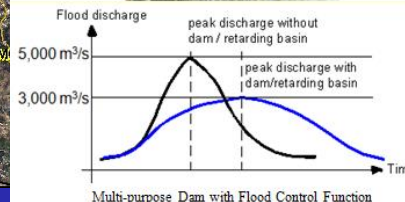
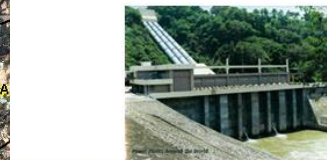
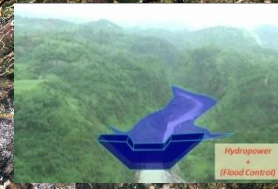
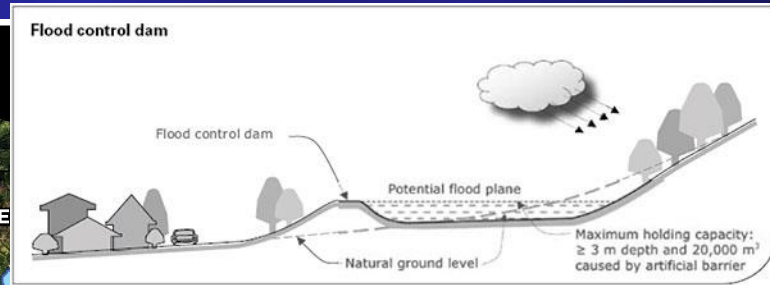
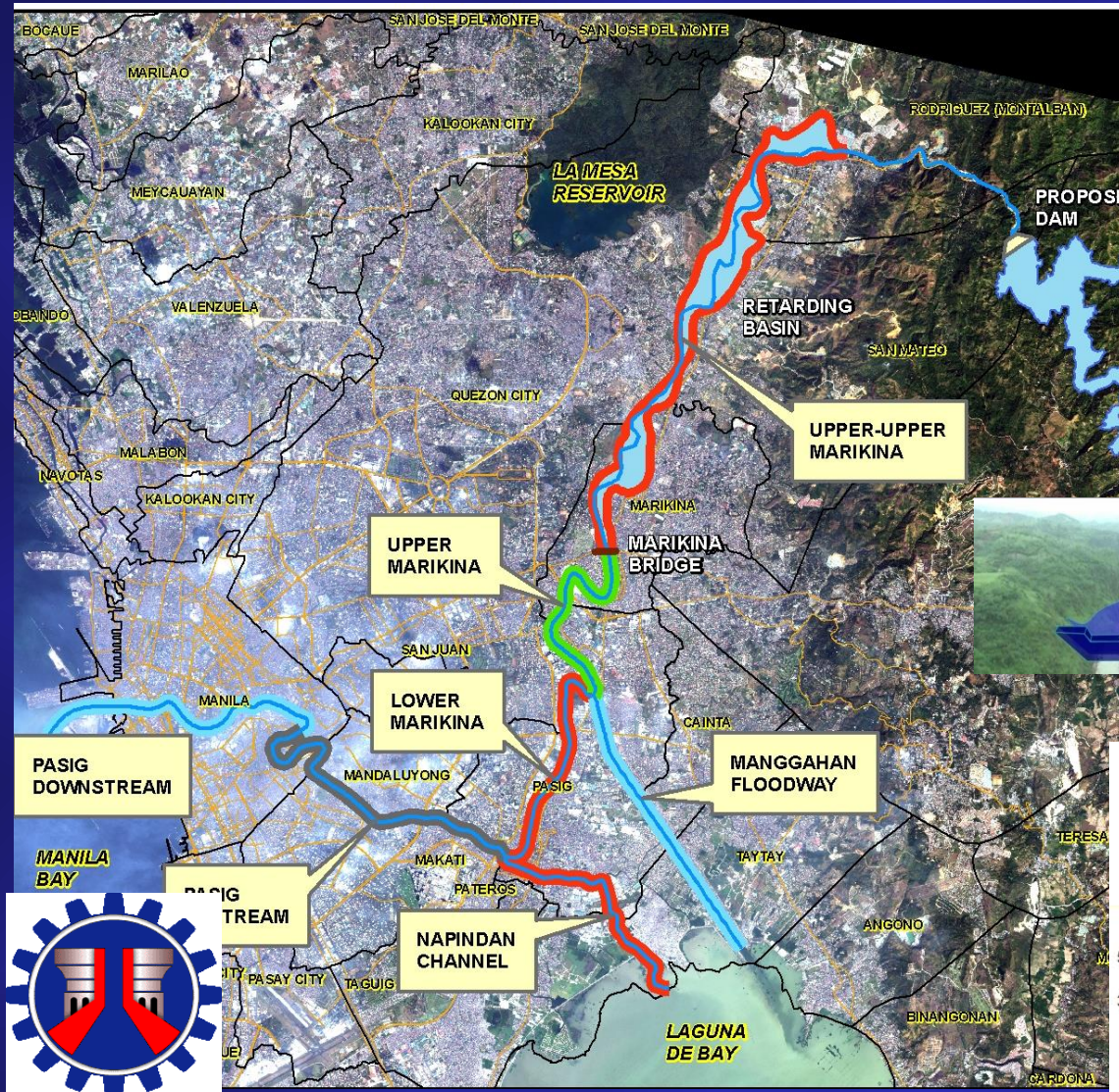
LEGEND

- MAJOR ROADS
- MUN/CITY BDY.
- CONCRETE DIKE
- EARTH DIKE



Marikina Dam

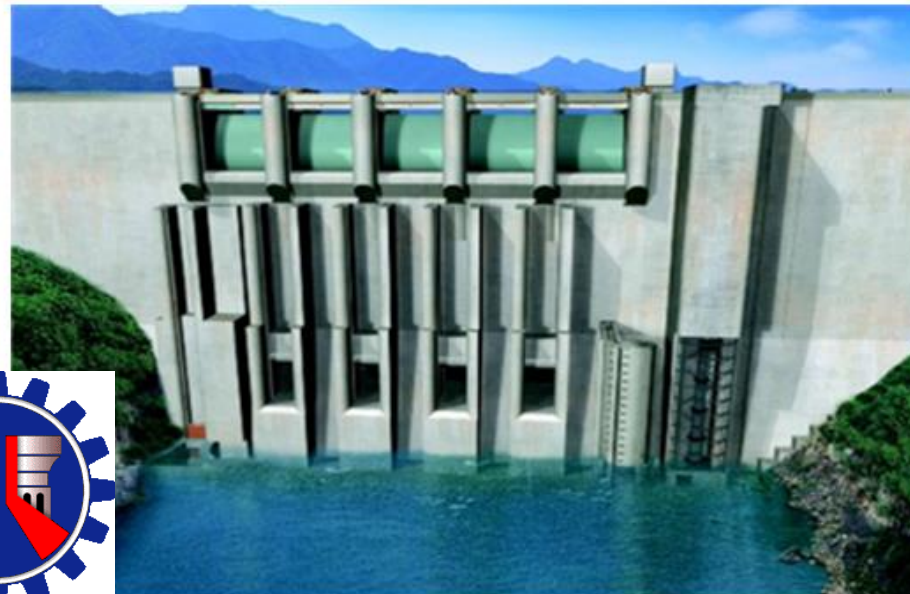
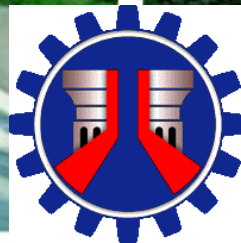
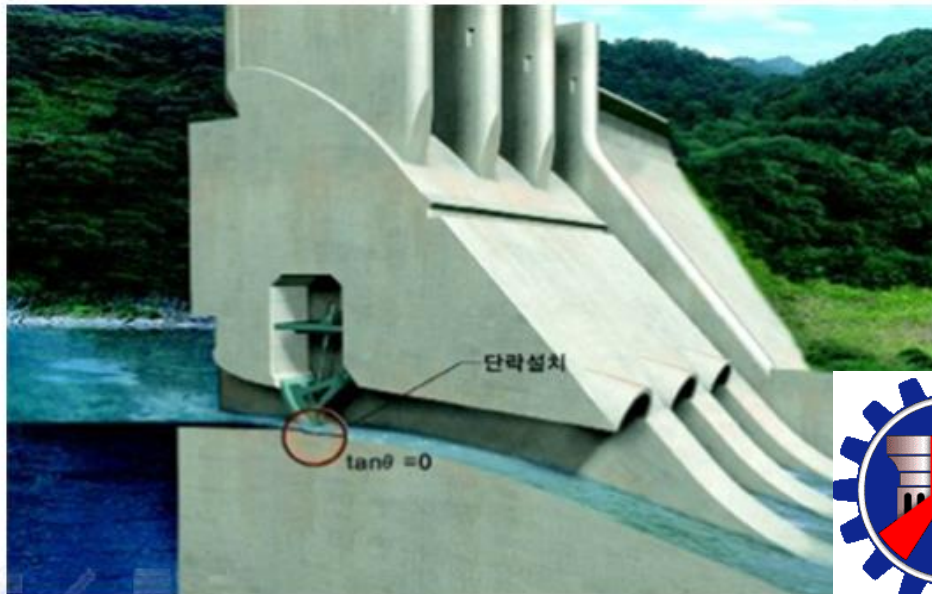
DPWH Efforts to Mitigate Flooding in Metro Manila



Retarding Basin

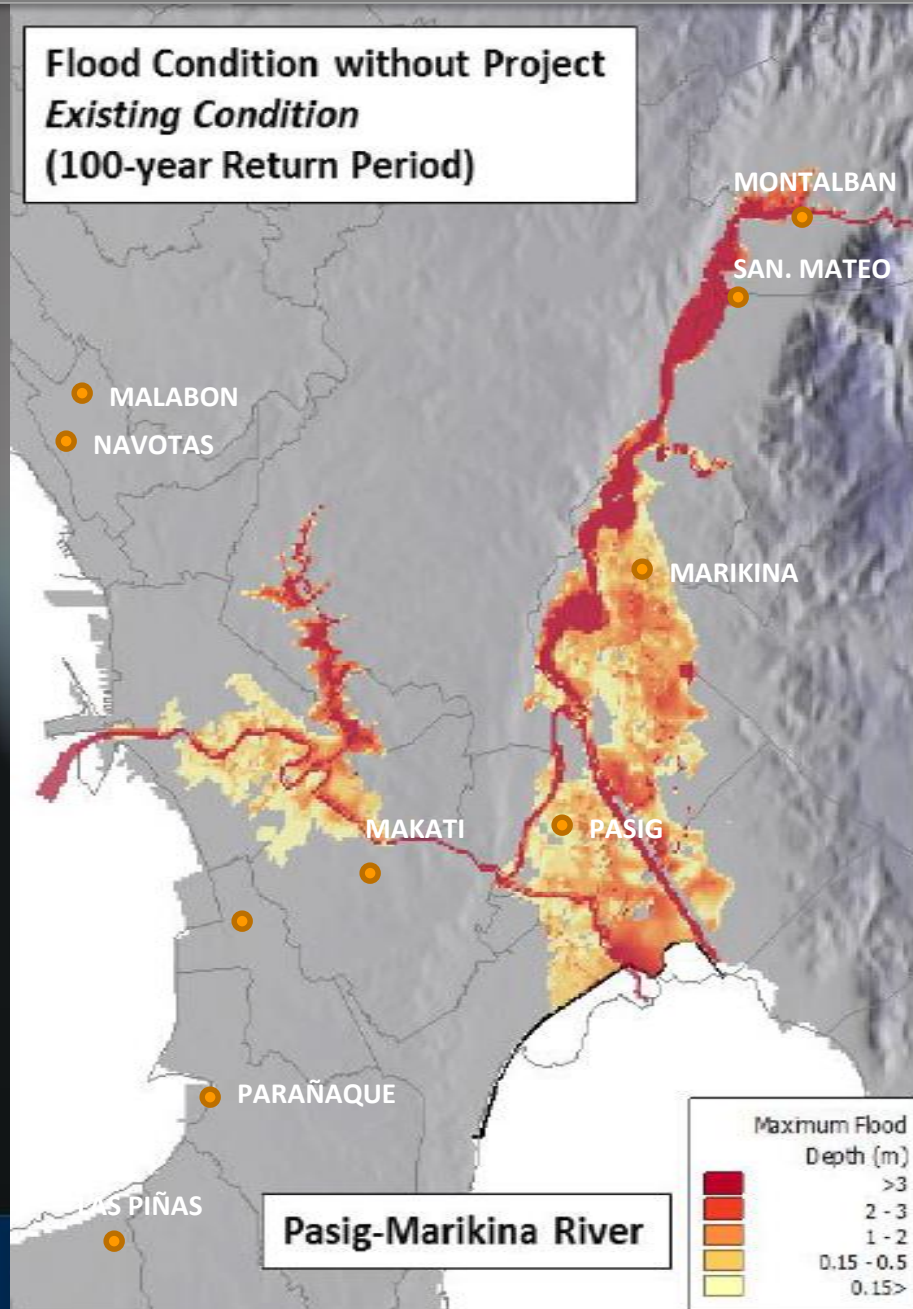
Marikina Dam

FEASIBILITY STUDY AND DETAILED ENGINEERING DESIGN OF THE PROPOSED UPPER MARIKINA DAM, GREATER METRO MANILA AREA FLOOD MANAGEMENT PROJECT

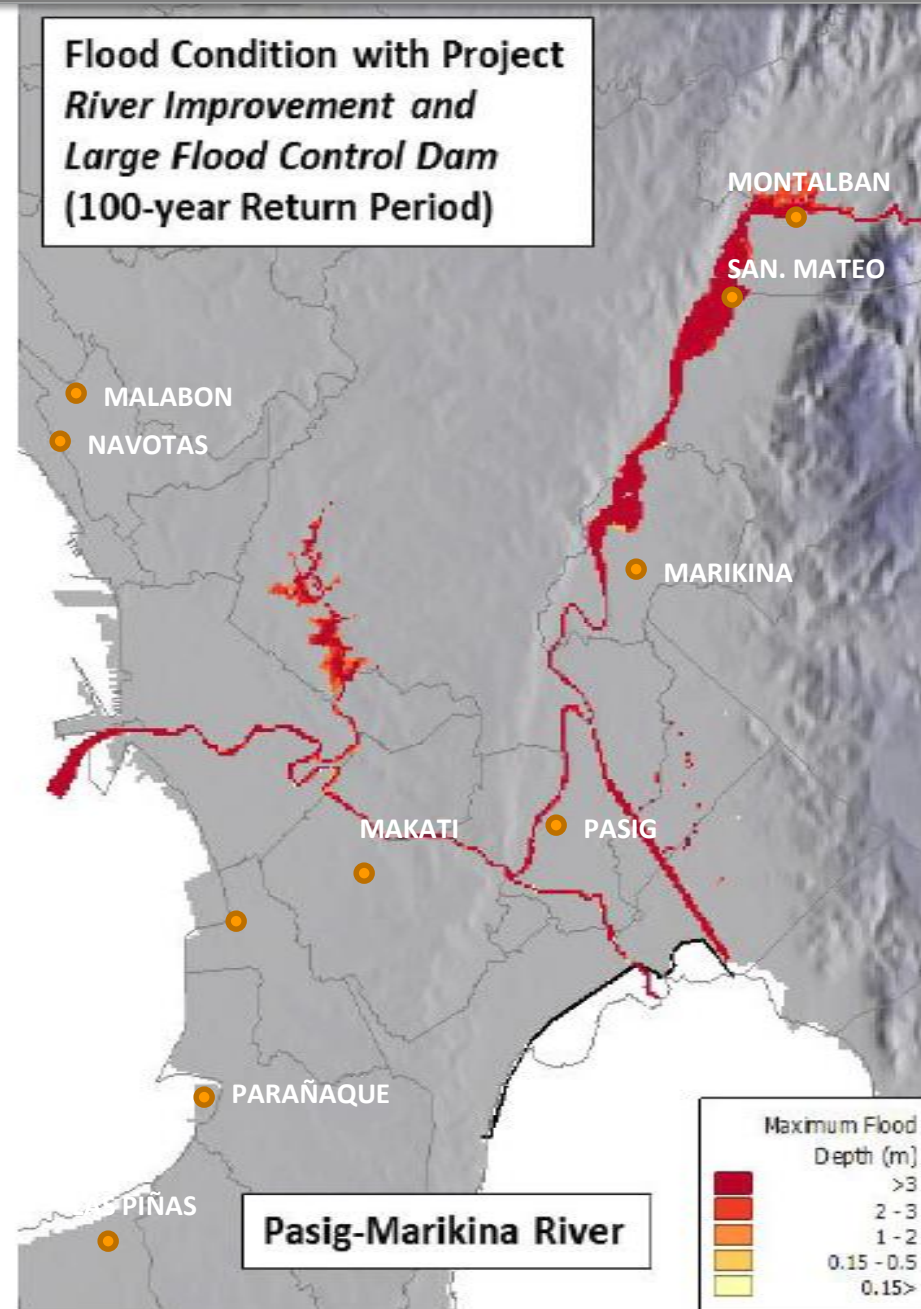


Comparison of Flood Condition in the Pasig-Marikina River Basin

Flood Condition without Project
Existing Condition
(100-year Return Period)



Flood Condition with Project
River Improvement and Large Flood Control Dam
(100-year Return Period)

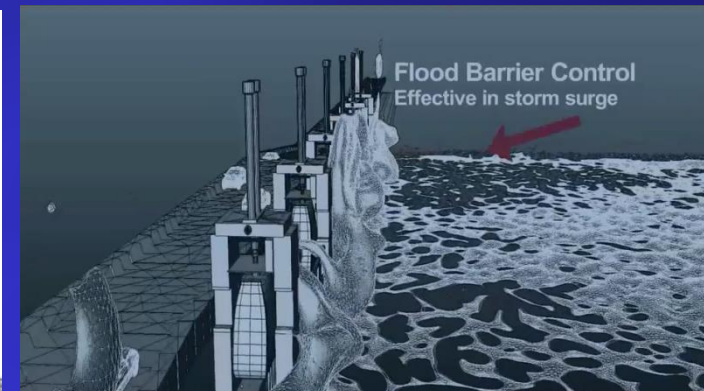
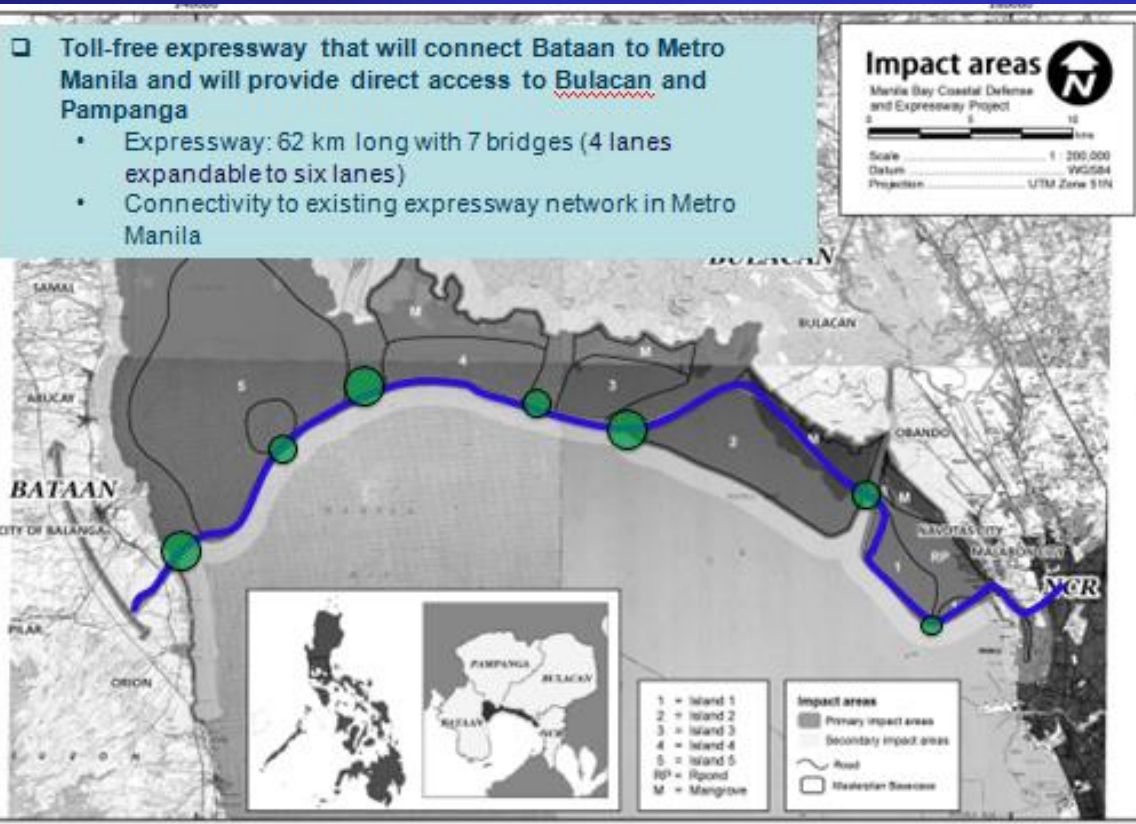


Policy Direction / Framework

DPWH Efforts to Mitigate Flooding in Metro Manila

4. Coastal Flood Defense and Sea Barrier

Metro Manila flood proofing thru flood gates and coastal sea barrier for protection against coastal flooding and storm surge

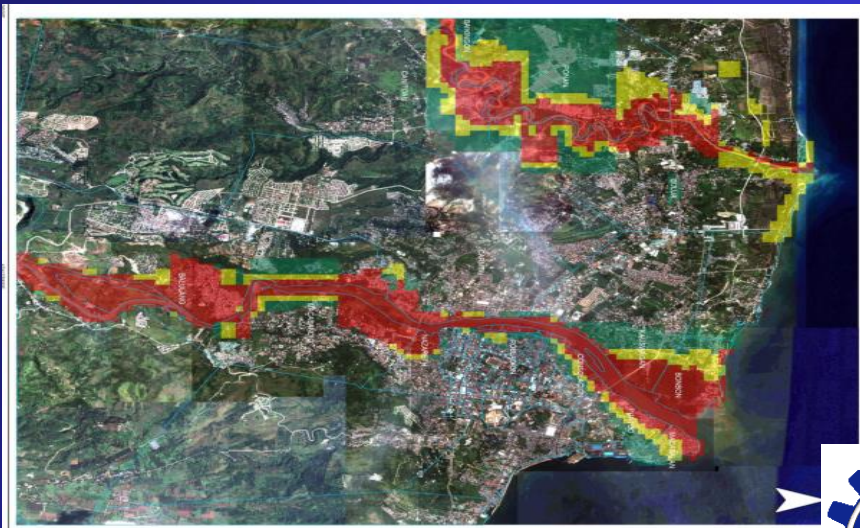


Issues and Challenges

Efforts to Mitigate Flood Disasters

Pursuing Integrated Flood Management

Hazard Map – Development of flood inundation map, pre-and-post flood disaster, that shows flood prone areas, no built-zones (no habitation zones) that reflects the old-cadastral river boundary



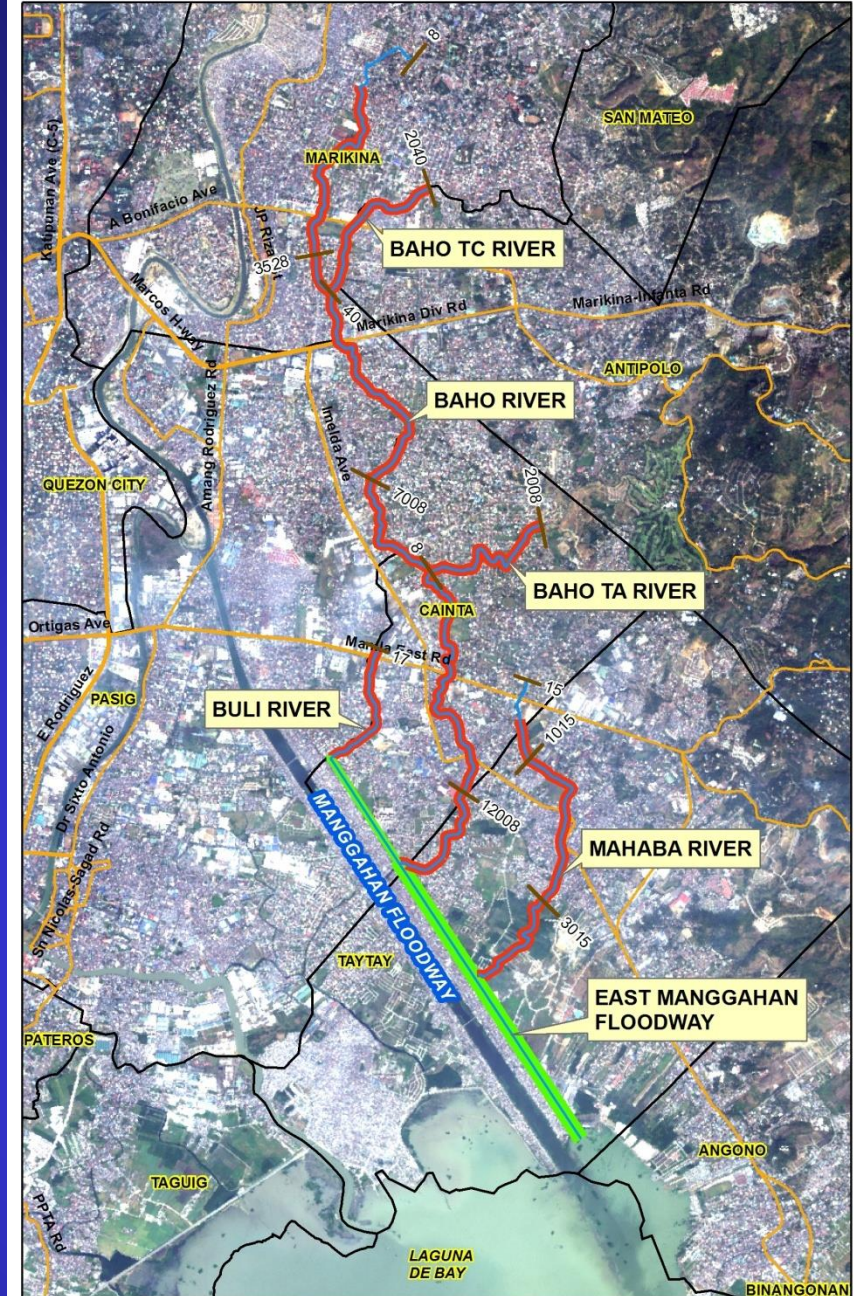
CDO Flood Hazard Map, Post-Sendong, 2012



Bottlenecking of CDO river at Ysalina Bridge

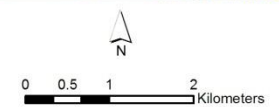
Issues and Challenges

Relocation of Informal Settler Families



LEGEND

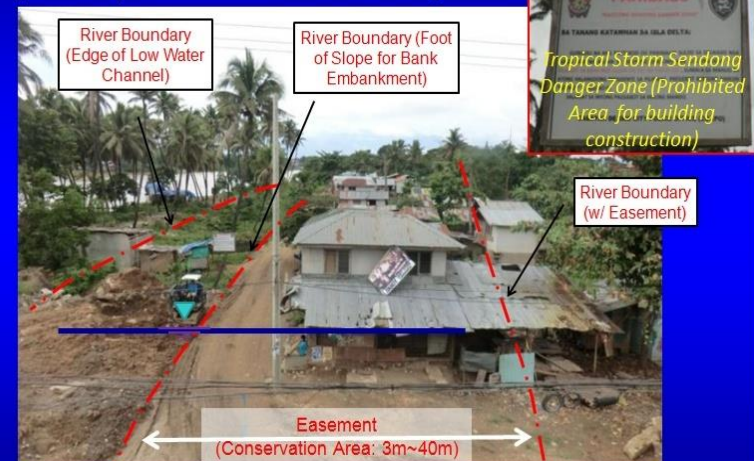
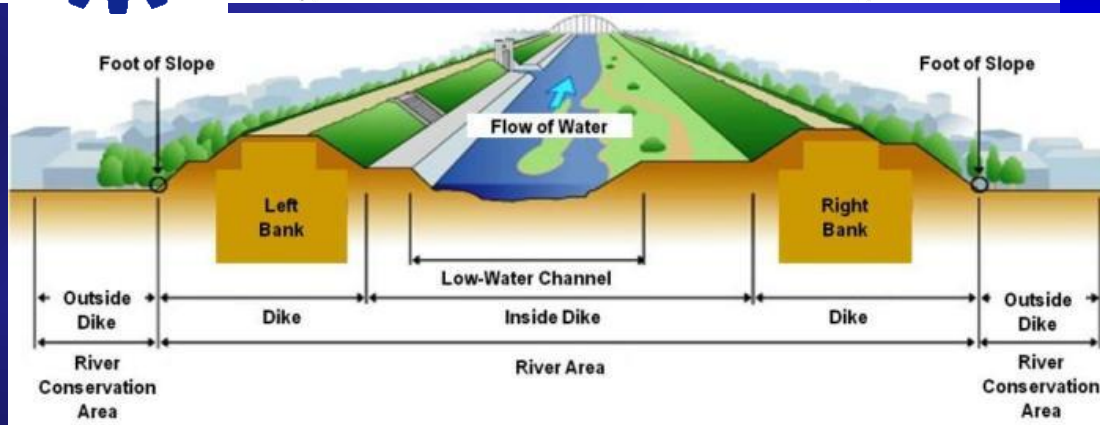
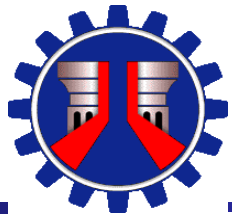
- MAJOR ROADS
- MUN/CITY BDY.
- CONCRETE DIKE
- EARTH DIKE



Efforts to Mitigate Flood Disasters

Article No. 51 - Designation of River Easements

Article No. 53 - Declaration of Flood Control Areas (No Build Zones)





Completed and On-going Initiatives

DPWH Efforts to Mitigate Flooding in Metro Manila

Completed and Ongoing Flood Control Projects



Pasig – Marikina River Improvement



Ormoc Flood Mitigation Project



Anilao Slit-Type Sabo Dam



Pinatubo Groundsills



Camiguin Sabo Dam



KAMANAVA Flood Control Project